HYDRAULIC DESIGN ADVISORY
HDA 05-05
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SUBJECT: Dan Anderson Peak Discharge Determinations – Procedural Revision

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As a result of discrepancies discovered in the design charts used with the Dan Anderson procedure (Appendices 6F-1 & 6F-2 from Chapter 6 of the VDOT DRAINAGE MANUAL) and our desire to eliminate, wherever possible and practicable, the use of graphic nomographs, we have revised the procedure for calculating discharges using the Dan Anderson method. The revised procedure eliminates the use of graphic nomographs and utilizes only the equations presented in Anderson's original publication. This will also assist in utilizing the Anderson method with computer programs, spreadsheets, and programmable calculators.

With the issuance of this Hydraulic Design Advisory, Appendices 6F-1 and 6F-2 of the VDOT DRAINAGE MANUAL are voided and the application of the Anderson method for VDOT purposes will be in accordance with the procedure described in the attachment for either manual calculations or computer programs, spreadsheets, or programmable calculators. The procedure described in the attachment will be added to the VDOT DRAINAGE MANUAL Errata Sheet and will be incorporated into the next revision to the VDOT DRAINAGE MANUAL. Areas where changes have been made are highlighted in gray. This revision will affect both Section 6.4.4.2.4 (where the Anderson method is described) and Section 6.5.2.2 (where an example Anderson calculation is shown) of Chapter 6 of the VDOT DRAINAGE MANUAL. If there are any questions, please contact Mr. LeGrande either by phone at (804) 371-2807 or by e-mail at David.LeGrande@VDOT.Virginia.gov.

6.4.4.2.4 Equations

The equation for the Anderson Method is as follows:

$$Q_f = R_f(230)KA^{0.82}T^{-0.48} \qquad (6.6)$$

Where:

Q_f = Maximum rate of runoff, cubic feet per second (cfs) for flood frequency “f” (i.e. 2.33, 5, 10, 25, 50, &100). For 500-yr. flood multiply calculated Q_{100} by 1.7.

R_f = Flood frequency ratio for flood frequency “f” based on percentage of imperviousness (obtained from formula shown below)

K = Coefficient of imperviousness (obtained from formula shown below)

A = Drainage area, square miles (sq. mi.)

T = Time lag, hours (See Table 6-3)

Table 6-3. Anderson Time Lag Computation

Time Lag, T	Watershed Description
$4.64\left(\frac{L}{\sqrt{S}}\right)^{0.42}$	For natural rural watersheds
$0.90\left(\frac{L}{\sqrt{S}}\right)^{0.50}$	For developed watersheds partially channelized
$0.56\left(\frac{L}{\sqrt{S}}\right)^{0.52}$	For completely developed and sewered watersheds

Where:

L = Length in miles along primary watercourse from site to watershed boundary

S = Index of basin slope in feet per mile based on slope between points 10 and 85 percent of L

$$K = 1 + 0.015\,I$$

Where:

I = Percentage of imperviousness, in whole numbers (e.g. for 20% imperviousness, use I = 20)

$$R_f = \frac{R_N + 0.01I(2.5R_{100} - R_N)}{1.00 + 0.015\,I}$$

Where:

R_N = Flood frequency ratio for 0% imperviousness (i.e. completely rural) for flood frequency “f” (see Table 6-3A)

R_{100} = Flood frequency ratio for 100% imperviousness for flood frequency “f” (see Table 6-3A)

Table 6-3A. Anderson Flood Frequency Ratios

f	**2.33**	**5***	**10**	**25**	**50**	**100**
$\mathbf{R_n}$	1.00	1.65	2.20	3.30	4.40	5.50
$\mathbf{R_{100}}$	1.00	1.24	1.45	1.80	2.00	2.20

* - Flood frequency ratio for the 5-yr. events were derived by VDOT, all others were taken directly from the D.G. Anderson report.

6.5.2.2.1 Anderson Method Sample Problem

Estimate the 25-year peak discharge on Rabbit Branch near Burke, Virginia, for an expected future development consisting of 40% impervious surface and a drainage system of storm sewers for tributaries but a natural main channel.

Step 1: From topographic maps, determine the following data

A = 3.81 sq. miles
L = 3.40 miles from crossing site to watershed boundary
Elevation = 282 feet at 10%L (0.34 miles) above crossing site
395 feet at 85%L (2.90 miles) above crossing site

Step 2: Compute the average channel slope

$$\text{Slope} = \frac{(395\text{-}282)}{(2.90\text{-}0.34)} = \frac{113}{2.56} = 44.2 \text{ ft/mi}$$

Step 3: Compute time - T

$$T = 0.9\left(\frac{L}{\sqrt{S}}\right)^{0.5} \text{ for Developed Watershed, Partly Channeled}$$

$$= 0.9\left(\frac{L}{\sqrt{S}}\right)^{0.5} = 0.9\left(\frac{3.4}{\sqrt{44.2}}\right)^{0.5} = 0.64 \text{ hrs}$$

Step 4: Compute K

K = 1.00+0.015 I, where I = 40% for impervious surface
= 1.00+0.015(40)
= 1.60

Step 5: Compute Flood Ratio (Rf) using equation from section 6.4.4.2.4 with a 25-yr RN of 3.3 and a 100-yr R100 of 1.8

$R_{25} = [R_N + 0.01I(2.5R_{100} – R_N)] / K$
$= [3.3 + 0.01(40)(2.5(1.8) – 3.3)]/1.6$
$= 2.36$

Step 6: Compute peak discharge (Q)

$Q_{25} = R(230)KA^{0.82}T^{-0.48}$
$= 2.36(230)(1.6)(3.81)^{0.82}(0.64)^{-0.48}$
$= 3222$ cfs (Say 3200 cfs)